PHOTOASSOCIATION OF RbSr MOLECULES ON HELIUM NANODROPLETS FROM SPATIALLY SEPARATED Rb AND Sr ATOMS.

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Superfluid helium nanodroplets enable the synthesis and spectroscopy of elusive molecules. When helium droplets are doped by travelling through two different pickup regions loaded Rb and Sr, RbSr molecules are formed on the droplet surface, which allowed for the spectroscopic characterization of many excited states as well as of the ground state of the RbSr molecule.\(^1\)

However, our experiments reveal that the formation of RbSr molecules is not the only outcome of the doping process: A certain fraction of Rb and Sr atoms remain spatially separated from each other. We show that RbSr molecules can be formed from these separated atoms by photoassociation upon excitation of the Sr-He\(_N\) 5s5p \(^1\)P\(_o\) \(\leftarrow\) 5s\(^2\) \(^1\)S\(_0\) transition.\(^2\) This is demonstrated by resonant two-photon ionization (R2PI) spectroscopy, where the initially excited Sr-He\(_N\) transition can be followed on mass channels corresponding to Rb atoms and RbSr molecules. A similar scenario is found for droplets doped with two Sr atoms.

The investigation of helium droplets doped with single Sr atoms reveals, by employing laser induced fluorescence (LIF) spectroscopy, that a fraction of the atoms does not desorb upon excitation of the 5s5p \(^1\)P\(_o\) \(\leftarrow\) 5s\(^2\) \(^1\)S\(_0\) transition. The detection of fluorescence from the 5s5p \(^3\)P\(_o\) \(\rightarrow\) 5s\(^2\) \(^1\)S\(_0\) intercombination line upon excitation of the 5s5p \(^1\)P\(_o\) \(\leftarrow\) 5s\(^2\) \(^1\)S\(_0\) transition indicates that droplet mediated relaxation of Sr atoms plays an important role.

The results provide evidence for an alternative pathway that can be undertaken by dopants upon pickup by a helium droplet and suggest that a situation with spatially separated dopants on one helium droplet may not be an exotic phenomenon restricted to weakly bound species. The photoassociation of molecules from these separated atoms may open up new prospects for the investigation of the formation of molecular bonds.
